Thoughts on the DCATT Experiment Plan

D. Redding

7/11/98

Goals

1) Achieve first light operation
2) Validate models used to predict NGST performance
   - Optics
   - Controls
   - Detection (?)
3) Determine performance limits of NGST baseline WF control system
   - Ultimate WFE/image quality performance achievable
   - Capture range
   - Optical tolerances, actuation limits, frequency limits
   - Failure modes
4) Evaluate alternative WF sensing and control algorithms, sensors, etc.
   - Phase retrieval
   - Phase diversity using extended scenes
   - Interferometric sensing
   - Wavefront control laws
5) Facility instrument, guest investigator program

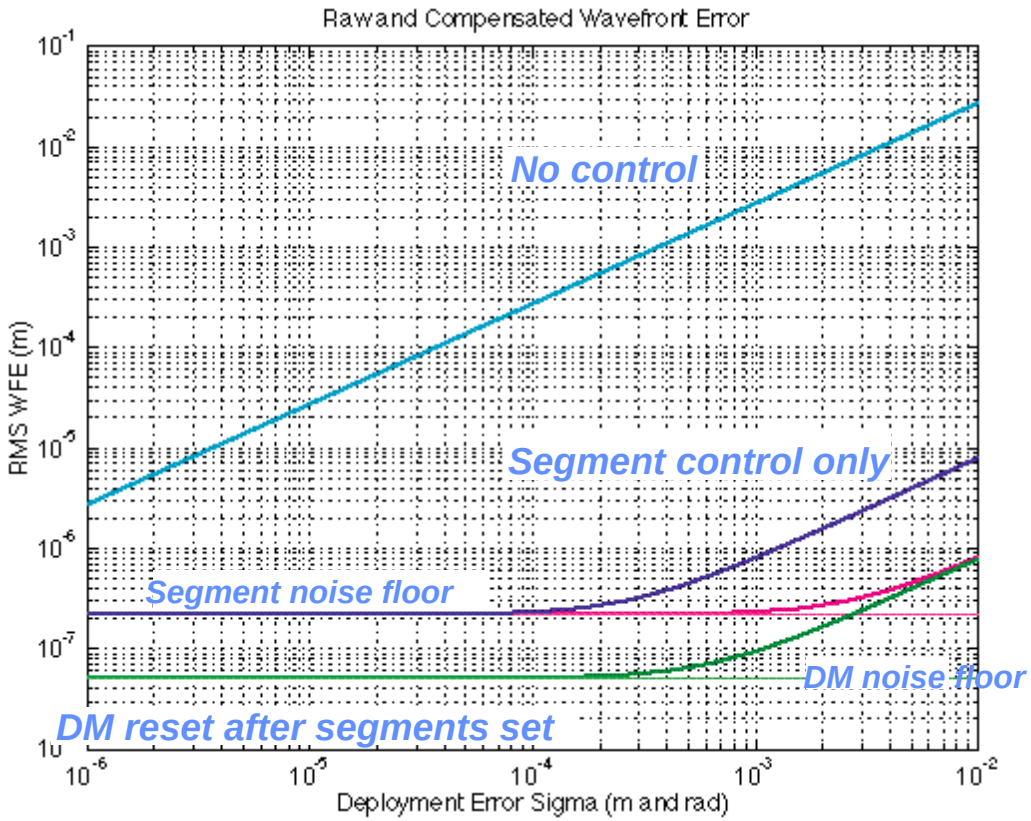
Single Experiment

- Perturb initial condition of the optics
  - Random initial alignment, generated according to particular std dev (σ_{align})
  - Random initial DM figure (σ_{DM})
  - Random initial PM figure errors (not part of DCATT Phase I)
- Capture, align, phase, fine phase, using:
  - Random actuation error (plus intrinsic error) (σ_{act})
  - Random detection noise / integration time (σ_{read}, σ_{photon})
- Allow low level of user control for debugging, experimentation, education
- Run model in parallel with hardware
- Measure and account for spurious environmental effects
  - Lab seeing, jitter, thermal distortions
- Performance
  - Scoring via IWFS
  - Measure WFE, in-focus PSF metrics
  - Measure model deviation from experiment

Monte Carlo Experiments

- Each single experiment begins as a realization of a statistical description of the pre-WFC DCATT optics and control system
  - ICs, error, noise generated from σ's
- Run many experiments and collect statistics on WFC performance
  - Performance statistics: WFE, Strehl vs. σ's
  - Model agreement statistics: ΔWFE, ΔStrehl vs. σ's
- Find break points
  - Capture range limits
    - Capture time
  - Performance limits
    - Noise floors
    - Resolution limits
    - Stroke limits

Alignment Error Example



NGST 8-Petal configuration
8 meter aperture
F/1.25 primary
F/24 system
λ = 1.0 μ***m (0% bandpass)***
Random initial segment state errors
Optimal WF controller
Set DM and segments together
Follow up with DM only
Phase sensing
Results via covariance analysis

Deployment error in 6DOF
Uniform variance
Segment actuation in 3DOF
Segment actuation error 8e-8 rad & m
DM actuation error 1e-9 m
Sensing error 1e-12 m

- Pre and post-WFC errors plotted vs. σ_{align}

Implications for DCATT

- Early first light
  - Hardware deliveries should be pacing software development
  - First Light Lite with simulator this summer
  - First Light Pro with PM when ready
- Single experiments/debugging
  - Options for low-level and manual control
- Environmental effects
  - If jitter is bad, adopt FSM in Phase I. Acoustics?
  - Thermal instrumentation?
  - Lab seeing, stray light – enclose beam
- Monte Carlo experiments
  - High level of automation for operation and data collection
  - Parallel operation of model and hardware
  - Unsupervised operation?
- Facility instrument
  - Ease of use, documentation, programmability important -- once past first light, first round of experiments